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PROCESS FOR FORMING METAL PLATING FILM, PROCESS FOR MANUFACTURING ELECTRONIC COMPONENTS AND APPARATUS FOR FORMING PLATING FILM

TECHNICAL FIELD

[0001] The present invention relates to a process for forming a metal plating film used as conductive patterns for electronic components, such as capacitors, inductors, filters, and wiring boards, to a process for manufacturing an electronic component constituted by combination of the metal plating film and a dielectric layer, and to an apparatus for forming the plating film used for formation of the metal plating film.

RELATED ART

[0002] Conventionally, electronic components, such as capacitors, inductors, filters, and wiring boards, are formed using dielectric materials, such as ceramic materials, and conductive materials.

[0003] As such conventional electronic components, for example, known well are multilayer capacitors wherein a plurality of ceramic layers having a predetermined dielectric constant are stacked so as to have a first internal electrode and a second internal electrode alternately interposed between the layers, and at the same time a pair of external electrodes electrically connected, respectively, are provided to the first and the second internal electrodes in a side surface and in a principal surface of the stacked layer.

[0004] The multilayer capacitors serve as a capacitor by applying a predetermined electrical potential difference between the first internal electrode and the second internal electrode in a ceramic layer disposed between the first internal electrode and second internal electrode to give a predetermined electrostatic capacity.

[0005] In addition, the above-mentioned multilayer capacitors are manufactured through following processes (for example, refer to Japanese Patent Laid-Open No. 2000-243650 official report).

[0006] Firstly, ceramic green sheets are formed in such a manner that an organic binder and an organic solvent are added to a predetermined ceramic material powder and mixed together to form an inorganic composition in a slurry state, and then the obtained slurry is molded to give a sheet having a predetermined thickness, using conventionally well-known doctor blade methods etc.

[0007] Then, a conductive paste including metals, such as nickel, as a principal component is printed and applied to a principal surface of the obtained ceramic green sheet, using a conventionally well-known screen printing method etc. with a given pattern. A stacked layer of the ceramic green sheet is formed by stacking two or more sheets of the obtained green sheets.

[0008] Then, the stacked layer is calcined at elevated temperatures to form a stacked layer of ceramic layers having interposed internal electrodes.

[0009] Finally, a conductive paste is then applied to end faces of the stacked layers etc. using a conventionally known dipping method etc., and calcined to form external electrodes, giving a multilayer capacitor.

[0010] In recent years, miniaturization of electronic components is required in accordance with progress of miniaturization of electronic apparatus, and in multilayer capacitors mentioned above, there have been made various measures for forming thinner ceramic layers and thinner internal electrodes.

[0011] For example, in the above-mentioned conventional multilayer capacitors, for obtaining internal electrodes having a small thickness, it is important to make extremely smaller a mean particle diameter of a metal powder included in a conductive paste currently used for formation of the internal electrodes, for example, up to a level of approximately 0.3 μm.

[0012] However, when the particle diameter of the metal powder included in the conductive paste is made extremely smaller, deterioration of dispersibility of the metal powder resulting from aggregation of the metal powder in the conductive paste makes it difficult to provide a conductive paste with characteristics suitable for screen printing etc.

[0013] In addition, even in the case where adjustment of various components included in the conductive paste can give the conductive paste characteristics suitable for screen printing etc., in calcination after thin coating of this paste on a ceramic green

sheet, there may be induced disadvantage that migration of the metal powder in the conductive paste during calcination might lose continuity of internal electrodes, leading to defects of possible cut off in internal electrodes in a worst-case.

[0014] Then, in order to overcome the above-mentioned defects, manufacturing of multilayer capacitors using thin metal plating films with a smaller thickness is now examined. In this case, a stacked layer is formed by stacking two or more sheets of ceramic green sheets having attached metal plating films thereon, and then a multilayer capacitor is manufactured by calcination of this stacked layer at elevated temperatures.

[0015] Metal plated films used as internal electrodes of such multilayer capacitors may be formed in such a manner that a mask having opening patterns with a shape corresponding to internal electrodes is formed on a metal substrate, and subsequently, the substrate is immersed into a plating bath to deposit a metal onto a surface of the substrate located in the opening of the mask using a conventionally known electrolytic plating method. The metal plating film is attached and formed on a ceramic green sheet by pressing the ceramic green sheet etc. onto one principal surface of such a substrate, and by transferring the metal plating film formed in the opening of the mask to the principal surface of the ceramic green sheet.

[0016] However, the above-described manufacturing process using metal plating films has a disadvantage of forming a large

internal stress (tensile stress) in the metal plating film during deposition of the metal plating film. Therefore when a metal plate used for deposition of the metal plating film has a flat surface, detach of the metal plating film from the metal plate shows a tendency of forming a curve having a convex form in a direction opposite to a direction of deposition of the metal plating film, that is, a tendency of formation of what is called "curvature". Therefore, induced are defects of occurrence of deformation and crack in the ceramic green sheet or the metal plating film in transfer of the metal plating film to the ceramic green sheet, or of occurrence of delamination during calcination.

[0017] Furthermore, in the above-described conventional manufacturing methods, excessively high peak temperatures in calcination of the stacked layer comprising ceramic green sheets may melt the metal forming the metal plating film, and may induce minute cutting off between the internal electrodes, leading to possible loss of function as a multilayer capacitor. Alternatively, excessively low calcination temperatures may reduce adhesive properties between the ceramic layer obtained by calcining the ceramic green sheet, and the metal plating film (internal electrode), leading to defect of occurrence of breakage, such as delamination.

[0018] An object of the present invention is to provide a process for forming a metal plating film that can provide a metal plating film having satisfactory detachability and having no

curvature.

[0019] Another object of the present invention is to provide a process for manufacturing an electronic component, wherein small electronic components can be manufactured using conductor layers having a smaller thickness, while occurrence of defects in a conductor layer or a dielectric layer, such as deformation and breakage, is effectively prevented.

[0020] Still another object of the present invention is to provide an apparatus having excellent productivity for forming a plating film, wherein a metal plating film having satisfactory detachability and having no curvature can be obtained.

SUMMARY OF THE INVENTION

[0021] A process for forming a metal plating film of the present invention comprises the steps of: preparing a base element having a convex curved surface; depositing a metal plating film onto the surface of the base element; and detaching the metal plating film from the base element.

[0022] In addition, a process for manufacturing an electronic component of the present invention comprises: a step A for depositing a metal plating film onto a surface of a base element; a step B for detaching the metal plating film from the base element, and for mutually attaching the metal plating film with a dielectric sheet; a step C for obtaining an electronic component having a portion with a conductor layer attached on a dielectric layer by heat treating the dielectric sheet having the formed metal plating

film thereon, at a temperature lower than a melting point of a metal forming the metal plating film.

[0023] According to the present invention, a given convex curve on a surface of the base element to have deposition of a metal plating film may form the metal plating film having a convex sectional configuration on the surface of the base element. Since an internal stress (tensile stress) arises within the metal plating film obtained in this way, the metal plating film is transfigured toward planarization when the metal plating film is detached from the base element and transferred on the dielectric sheet. Thus, on transfer recipient materials, such as the dielectric sheet having a transferred metal plating film thereon, occurrence of deformation and breakage of the metal plating film are effectively prevented, leading to improvement in productivity.

[0024] In addition, since the metal plating film mentioned above is heat-treated with the dielectric sheet at temperatures lower than the melting point of the metal forming the metal plating film, cut of the metal plating film by melting of the metal plating film in heat treatment does not occur, enabling formation of a conductor layer having excellent continuity.

[0025] In the process for forming the metal plating film, for example, materials having cylindrical surface may be used as the base element. A metal plating film may be deposited on a surface of a base element by immersing a part of a surface of the base element in a plating solution in a plating bath, and by applying an electric

field between the base element and the plating bath, while the base element turns on its axis.

[0026] An apparatus for forming the plating film of the present invention comprises: a plating bath having a plating solution introduced therein; a rotatable base element having a cylindrical surface, the base element being disposed so that a portion of a surface thereof may be immersed in the plating solution; an electric field applying means for applying electric field between the base element and the plating bath; and a transfer means for pressing the metal plating film onto the surface of the base element elevated out from the plating solution by pressing a transfer recipient material to the base element, in a downstream side of a rotative direction of the base element.

[0027] A metal plating film may continuously be formed in such a manner that a base element on which a metal plating film is deposited is made in a shape of drum or cylinder, and a portion of the base element is immersed in a plating solution in a plating bath while the base element turns on its axis, and concurrently electric field is applied to the plating solution between the base element and the plating bath to form the metal plating film in a deposition process of the metal plating film, thus leading to improvement in productivity. In addition, a current density between the base element and the plating bath may be set approximately uniform to form the metal plating film with an approximately uniform thickness.

[0028] After the metal plating film on a surface of the base element elevated out from the plating solution is pressed in such a manner of pressing a transfer recipient material onto a base element, the metal plating film is once transferred onto a resin film, and then a dielectric sheet is attached thereon, or the metal plating film is re-transferred onto the dielectric sheet. According to this process, since the dielectric sheet does not contact directly to a mask layer on a surface of the base element formed with hard materials, the metal plating film may advantageously be attached satisfactorily to the dielectric sheet without damage of the dielectric sheet by contact with the mask layer.

[0029] In case of detaching of the metal plating film from the base element, the metal plating film may be transferred directly onto a dielectric sheet of a resin film having the dielectric sheet formed thereon. According to this process, although the dielectric sheet contacts to the mask layer on the surface of the base element formed with hard materials, direct transfer of the metal plating film onto the dielectric sheet without interposition of the resin film can simplify an apparatus configuration.

[0030] In addition, after detaching of the metal plating film from the base element and transfer to the resin film, a dielectric slurry is attached so as to cover the metal plating film transferred to the resin film, and subsequently the resin film having the dielectric slurry attached thereto may be dried. According to this

process, the metal plating film on the resin film can be embedded in the dielectric sheet. This method enables formation of the almost flat dielectric sheet without a level difference between a region with existence of a metal plating film and a region without existence. Since deformation of the metal plating film is satisfactorily suppressed even with a plurality of such dielectric sheets laminated thereto, electric defects, such as delamination, may effectively be prevented.

[0031] In the present invention, a mask layer for controlling a deposition area of the metal plating film may be formed on a surface of the base element. The mask layer comprises, for example, diamond-like carbon (DLC) or graphite-like carbon (GLC). In this case, since sufficient electric insulation can be obtained by a mask layer having a comparatively smaller thickness, satisfactory detachability in case of detaching of the metal plating film from the base element can be attained, and furthermore the above-described hard DLC or hard GLC hardly form adhesion on the mask layer surface of the dielectric sheet in case of direct transfer of the metal plating film to the dielectric sheet, advantageously enabling repeated stable transfer.

[0032] In the present invention, non-conductive micro-particles are preferably included in the metal plating film. When the plating solution includes the non-conductive micro-particles, a metal plating film including the non-conductive micro-particles may be obtained by attachment of the non-conductive

micro-particles to a metal component in deposition of the metal plating film onto a surface of the base element. Since attach of the non-conductive micro-particles to the metal component deposited onto the surface of the base element forms a metal plating film including non-conductive micro-particles, an adhesion force between the metal plating film and the base element becomes comparatively smaller, enabling easy detach of the metal plating film from the base element.

[0033] In the present invention, a peak temperature in heat treatment of a dielectric sheet comprising a laminated metal plating film is preferably higher than a recrystallizing temperature of a metal constituting the metal plating film. The metal plating film described above is heat-treated with a dielectric sheet at temperatures lower than a melting point and higher than a recrystallizing temperature of a metal forming the metal plating film. Thus, a conductive layer having excellent continuity may be formed without cut of the metal plating film caused by melting of the metal plating film in heat treatment, and simultaneously progress of recrystallization of the metal forming the metal plating film moderately softens the metal, and thereby a conductor layer having excellent adhesive properties to the dielectric layer may be obtained.

[0034] Furthermore, in the present invention, after detaching of a metal plating film from the base element and transfer to a resin film, a thin dielectric sheet having a thickness

approximately equal to a thickness of the metal plating film is pressed onto both of a region with existence of the metal plating film and a region without existence on a surface of the resin film having the metal plating film formed thereon, and thus the dielectric sheet may selectively be attached to the region without existence of the metal plating film of the resin film. The metal plating film is transferred onto a principal surface of the resin film having an adhesive layer, and then the dielectric sheet having a thickness almost equal to a thickness of the metal plating film is pressed onto both of this region with existence of the metal plating film, and the region without existence. In this way, the dielectric sheet is selectively pressed only onto a region (a region with existence of the metal plating film) having the adhesive layer exposed, and as a result the metal plating film and the dielectric sheet are attached and formed almost without formation of a large space therebetween on the resin film. Therefore, after detaching them from the resin film, when a stacked layer comprising the dielectric sheets is formed by stacking two or more sheets of them having the dielectric sheets etc. being intervenient between them, both principal surfaces of the stacked layer may be made planar. Therefore even when electronic components are produced by heat-treatment of the stacked layer obtained, electric defects, such as delamination, will hardly occur, leading to production of electronic components having outstanding reliability and productivity.

[0035] In an apparatus for forming the plating film of the present invention, a surface of the base element may be sectioned into a plurality of blocks detachably supported to a core part of the base element. This configuration enables processing of a mask formation etc. and maintenance for every member in the block unit, and makes handling and assembly of facilities easier.

[0036] Moreover, in an apparatus for forming the plating film of the present invention, when the plating bath has a configuration having a first electric potential area maintained in a comparatively positive electric potential with respect to the base element, and having a metal plating film to be deposited onto a surface of the base element, and a second electric potential area for re-dissolving, into the plating solution, a surface portion of the metal plating film deposited onto the surface of the base element, the second electric potential area being disposed in a downstream in a rotative direction of the base element of the first electric potential area, and being maintained in a comparatively negative electric potential with respect to the base element, the surface portion of the metal plating film once formed, especially a portion in contact with the base element, may be re-dissolved into the plating solution, to form a minute space between the metal plating film and the base element, thereby enabling improvement of detachability of the metal plating film. Interposition of an insulated member between the first electric potential area and the second electric potential area enables electric isolation of both

areas.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view showing a multilayer capacitor manufactured by a process for manufacturing an electronic component of the present invention;

Fig. 2 is a side view schematically showing an apparatus for forming the plating film of the present invention wherein a base element 9 is rotatably disposed in a plating bath 18, a transfer means of the metal plating film is disposed in a side opposite to a plating bath 18 with respect to the base element 9;

Fig. 3 is a plan view of the base element 9 used for this apparatus for forming the plating film observed in a top direction (a direction of A of Fig. 2);

Fig. 4 is an expansion sectional side elevation showing a configuration of a surface of the base element used for this apparatus for forming the plating film;

Fig. 5 is a side view schematically showing an apparatus for forming the plating film of the present invention wherein a metal plating film 8 once transferred to a resin film 20 is re-transferred onto a surface of a ceramic green sheet 26 maintained on a resin film 25;

Fig. 6 is a side view schematically showing an apparatus for forming the plating film of the present invention wherein a metal plating film 8 deposited on a base element 9 is directly transferred onto a principal surface of a ceramic green sheet 26 maintained

on a resin film 25;

Fig. 7 is a sectional view for describing a process wherein a thin dielectric sheet 43 for filling a level difference is formed, in a portion without existence of a metal plating film 8, to a resin film 20 having a metal plating film 8 transferred from a base element 9;

Fig. 8 is a side view schematically showing an apparatus for forming the plating film of the present invention wherein a ceramic slurry 31 is applied to a principal surface of a resin film 20 having a transferred metal plating film 8 so as to cover a metal plating film 8, and the ceramic slurry is dried to obtain a ceramic green sheet 26 having an embedded metal plating film 8;

Fig. 9 is a side view schematically showing an apparatus for forming the plating film of the present invention wherein a plating bath 18 is sectioned into a higher potential area 18A serving as an cathode, and a lower electric potential area 18B serving as an anode;

Fig. 10 is a side view schematically showing an apparatus for forming the plating film of the present invention wherein while a plurality of insulated partition wall members 35 is disposed at a predetermined distance on a surface of a base element 4, the base element 4 is constituted so that a block member 36 having a mask layer 7 formed on a conductive film 6 may be inserted between the insulated partition wall members 35 on an insulating material 34; and

Fig. 11 is a side view schematically showing an apparatus for forming the plating film of the present invention wherein not only a surface portion of a base element 4 but a core part are blocked.

BEST MODE FOR CARRYING-OUT OF THE INVENTION

[0037] Embodiments of the invention will, hereinafter, be described in detail, referring to accompanying drawings.

- Multilayer ceramic capacitor -

[0038] Fig. 1 is a sectional view showing a multilayer capacitor manufactured according to a process for manufacturing an electronic components of the present invention. A multilayer capacitor 1 in the Figure is constituted of: a dielectric layer 4 stacked into a plurality of layers; internal electrodes 3 formed in each dielectric layer 4; insulating layers 2 sandwiching the dielectric layer 4 from upper and lower sides; and external electrodes 5.

[0039] This multilayer capacitor 1 may be obtained by forming internal electrodes 3 in a dielectric layer 4 having a predetermined dielectric constant, and by stacking them by turns to form a rectangular parallelepiped-shaped stacked layer. Insulating layers 2 comprising a same material as that of the dielectric layer 4 is formed on both of upper and lower sides of the stacked layer. Furthermore, external electrodes 5 electrically connected with the internal electrodes 3 are attached and formed on both ends of the stacked layer. An external size of this multilayer capacitor 1,

for example, has a width of 1.2 mm, a length of 2 mm, and a height of 1.2 mm.

[0040] The dielectric layer 4 is formed with ceramic materials or organic materials. In case of ceramic materials, for example, barium titanate, titanic acid calcium, strontium titanate, etc. may be used. In case of organic materials, for example, PET (polyethylene terephthalate), PEN (polyethylene naphthalate), PP (polypropylene), PPS (polyphenylene sulfide), etc. may be used. A thickness of the dielectric layer 4 is set, for example, as 1.0 μm to 4.0 μm per layer. A number of stacked layers are set, for example, as 30 layers to 600 layers. As materials of the insulating layer 2, same ceramic materials and same organic materials as those of the dielectric layer 4 may be used.

[0041] The internal electrodes 3 interposed between the dielectric layers 4 comprise, for example, nickel, copper, silver, gold, platinum, palladium, chromium, and alloys of these metals etc. A thickness is set, for example, as 0.5 μm, to 2.0 μm.

[0042] Materials, a thickness, and a number of stacked layers of the dielectric layer 4, an opposing area of the internal electrodes 3, etc. may appropriately be determined based on electrostatic capacities etc. of the multilayer capacitor desired.

- Apparatus for forming the plating film -

The multilayer capacitor mentioned above is manufactured using the apparatuses for forming the plating film in Figs. 2 to 4.

[0043] Fig. 2 is a side view schematically showing an

apparatus for forming the plating film of the present invention, Fig. 3 is a plan view of the base element 9 used for this apparatus for forming the plating film observed in a top direction (a direction of A of Fig. 2), and Fig. 4 is an expansion sectional side elevation showing a configuration of a surface of the base element used for this apparatus for forming the plating film.

[0044] The apparatus for forming the plating film has a configuration wherein a base element 9 is rotatably disposed in a plating bath 18, a transfer means of a metal plating film is disposed in a side opposite to a plating bath 18 with respect to the base element.

[0045] Descriptions about each structural element of the apparatus for forming the plating film will, hereinafter, be given. In addition, for example, cleaning means, washing liquid suction means, plating solution suction means, and circulation system are regarded as not indispensable structural elements in the apparatus for forming the plating film, but regarded as additional structural elements of the present invention among structural elements described below.

= Base element =

[0046] The base element 9 serves as a cathode of the apparatus for forming the plating film. For example, this is formed with metals having conductivity, such as stainless steel, iron, aluminum, copper, nickel, titanium, tantalum, molybdenum, etc. A conductive film 6 (refer to Fig. 4) is formed on all over circumference of

a surface of the base element 9. On a surface of the conductive film 6, a mask layer 7 for exposing the conductive film 6 to a given pattern is formed. Hereinafter, a surface and the conductive film 6 of the base element 9 are in combination referred to as "a surface of a base element".

[0047] The surface of the base element 9 has a cylindrical shape, a radius of curvature thereof is set, for example, in a range of 50 mm to 2000 mm, and a surface roughness is set as not more than 0.5 μm as a maximum height of irregularities Ry, for example. That is Ry <= 0.5 μm.

[0048] As the conductive film 6 formed on a surface of the base element 9, for example, materials having a specific resistivity of not more than 10^{-2} Ω-cm is used. In order to obtain a uniform current density in electrolytic plating, materials having a specific resistivity of not more than 10^{-3} Ω-cm is preferable. As materials of the conductive film 6 having a specific resistivity of not more than 10^{-3} Ω-cm, for example, titanium nitride aluminum, chromium nitride, titanium nitride, titanium nitride chromium, carbonitride titanium, titanium carbide, conductive DLC (diamond like carbon), etc. may be used. In addition, in materials of the conductive film 6, the conductive film 6 is preferably formed with titanium nitride aluminum, chromium nitride, titanium nitride, titanium nitride chromium, carbonitride titanium, etc. in order to improve detachability of the metal plating film 8. In order especially to increase durability, the conductive film 6 is

preferably formed with titanium nitride etc. The conductive film 6 is formed on a surface of the base element 9 using conventionally known thin film forming methods, for example, a sputtering method, an ion plating method, a chemical vapor deposition (CVD) method, etc.

[0049] The mask layer 7 formed on the surface of the conductive film 6 is used in order to control a deposition area of the metal plating film 8. The mask layer 7 preferably has sufficient electric insulative property. For example, the specific resistivity is preferably set as not less than 10^4 Ω-cm. For example, materials having a Vickers hardness Hv of not less than 1000 and a coefficient of friction μ of not more than 0.3 is used. As materials satisfying such characteristics, for example, DLC, GLC (graphite-like carbon), etc. with amorphous structure may be mentioned.

[0050] Thus, the mask layer 7 for controlling a deposition area of the metal plating film 8 is formed on the surface of the base element 9, and thereby a metal plating film 8 having a desired pattern may easily be obtained by simply immersion of the base element 9 into a plating solution 19 and impression of electric field between the plating bath 18 and the base element 9 mentioned later, without complicated processes, such as photoetching.

[0051] A thickness of the mask layer 7 is preferably formed with a same thickness as a thickness of the metal plating film 8, or a little thicker than the thickness of the metal plating film

8. This is for preventing the metal plating film 8 to grow exceeding a thickness of the mask layer 7 extending on the mask layer 7.

[0052] Here, an angle α of a corner portion formed between a side surface of the mask layer 7 and a bottom (refer to Fig. 4) is preferably set to not more than 90 degrees, for example, 90 degrees to 85 degrees. Thus, if the angle is set as not more than 90 degrees, an area of a lower surface of the metal plating film 8 contacting the base element 9 will be smaller than an area of the upper surface, and thereby a peripheral part of the metal plating film 8 may not easily caught in the mask layer 7, in transfer of the metal plating film 8 to a resin film 20 etc., enabling easy detaching of the metal plating film 8.

[0053] Using conventionally well-known thin film forming methods, such as a sputtering method, an ion plating method, and a CVD method, for example, DLC, GLC, etc. are attached and formed onto a surface of the base element 9 so as to have a predetermined thickness, and subsequently the DLC, GLC, etc. are processed into a pattern having a plurality of openings by well-known photoetching method etc. to form the mask layer 7. The opening serves as a region corresponding to a deposition area of the metal plating film 8.

[0054] Since DLC and GLC used as materials of the mask layer 7 have a comparatively high electric resistance, they do not permit deposition of plating onto the surface of the mask layer 7, and furthermore they provide excellent detachability and smaller frictional resistance to the surface. Therefore, probability that

a transfer recipient material may receive damage will decrease in the case of transfer of the metal plating film 8 to a resin film 20 as a transfer recipient material etc. Thus, durability of the base element 9 may increase by selecting materials of the mask layer 7, and thereby a metal plating film 8 with high quality may be obtained even by repeated use over long periods of time.

[0055] The above described base element 9 is rotatably supported by a rotatable shaft 10, as shown in Fig. 2. This rotatable shaft 10 is connected with a main shaft of a motor, and base element 9 may be rotated by transmitting a rotational movement of the motor around the shaft. And this rotatable shaft 10 is connected to an electric power unit 11 via a rotary brush, and thereby negative electrical potential difference is applied to the base element 9. That is, the base element 9 will serve as a cathode of the apparatus for forming the plating film.

= Plating bath =

[0056] A plating bath 18 serves as an anode of the apparatus for forming the plating film, and simultaneously serves as a container for forming the plating bath by containing a plating solution 19 therein.

[0057] Both of an inside surface of the plating bath 18 and a surface of the base element 9 are disposed almost in a concentric circle shape so that a fixed distance may be formed therebetween. A distance between the surface of the base element 9 and the inside surface of the plating bath 18 is set, for example as 2 mm to 50

mm.

[0058] The plating solution 19 is forced to flow between the base element 9 and the plating baths 18 with a predetermined rate of flow by a circulation system 15 etc. mentioned later. When forming a nickel plating film, may suitably be used sulfamic acid nickel plating solution etc., as the plating solution 19, suitable for obtaining a metal plating film 8 having a smaller internal stress. As such sulfamic acid nickel plating solution, for example, may be used an aqueous solution having a composition of: nickel chloride 30 g/l (liter); nickel sulfamate 300 g/l; and boric acid 30 g/l. A pH value is set, for example, at 3.0 to 4.2. For obtaining a metal plating film 8 having an especially small internal stress, a pH value is preferably set at 3.5 to 4.0, and at the same time a temperature of the plating solution 19 is preferably set at 45 °C to 50 °C.

[0059] And non-conductive micro-particles 30 comprising ceramics, resins, etc. are preferably added into the plating solution 19.

[0060] In addition, the plating solution 19 mentioned above may appropriately include, if necessary: buffers for pH comprising boric acid, formic acid nickel, nickel acetate, etc.; pit prevention agents comprising sodium lauryl sulfate etc.; stress reducers comprising chemicals obtained by adding sulfonic acid, sulfonates, sulfonamides, sulfone imides, etc. in aromatic hydrocarbons, such as benzene and naphthalene; curing agents

comprising aromatic sulfonic acid and derivatives thereof; and lubricating agents comprising butynediol, 2-butyne-1,4diol, ethylene cyanohydrin, formaldehyde, coumarin, pyrimidine, pyrazole, imidazole, etc. As the stress reducers, for example, there may be used saccharin, para toluene sulfonamide, benzene sulfonamide, benzene sulfone imide, sodium benzene disulfonate, sodium benzene trisulfonate, sodium naphthalene disulfonate, sodium naphthalene trisulfonate, etc.

[0061] An electric potential may be applied between the plating bath 18 and the base element 9 mentioned above, and, a conventionally well-known electrolytic plating method may be performed. That is, an electric potential applied between the base element 9 as a cathode, and the plating bath 18 as an anode deposits a metal plating film 8 to an area without existence of a mask layer 7 in surface areas of the base element 9.

[0062] In addition, since the plating solution 19 in the plating bath 18 is always forced to flow between the base element 9 and the plating baths 18 in a predetermined direction as described above, uniform quality of film of the metal plating film 8 may advantageously be obtained.

= Transfer means =

[0063] The transfer means is constituted of a resin film transfer means for transferring the metal plating film 8 to a principal surface of a resin film 20, and a ceramic green sheet transfer means for attaching a principal surface of a ceramic green

sheet 26 to the metal plating film 8 transferred onto the resin film 20.

[0064] The resin film transfer means is constituted of a delivery part 22, a pressurizing roller 23, and a taking up part 24. The delivery part 22 is used for connecting, with a motor, a roll shaft having the resin film 20 with an adhesive layer wound therearound, and for delivering out the resin film 20 with a predetermined amount of rotation of this shaft. The pressurizing roller 23, while rotating the resin film 20 with the adhesive layer, is used in order to pressurize the resin film 20 to the base element 9. The taking up part 24 includes a roller for taking up, with a fixed force, the resin film 20 with adhesive layer having the metal plating film 8 that has been transferred by passing through the pressurizing roller 23.

[0065] For enabling uniform application of pressure of the resin film 20 to the base element 9, the pressurizing roller 23 is preferably covered with elastic materials, such as a polyurethane rubber coat, a neoprene rubber material coat, and a natural rubber coat, at least in a surface portion thereof. The pressurizing roller 23 may not be connected with the motor and may be freely rotatable, and it may be connected with the motor and may perform rotating operation.

[0066] The resin film 20 to be used comprises, for example, a polyethylene terephthalate film (PET film) etc. having a thickness of 20 µm to 50 µm, and an adhesive layer 21 having a

thickness of 0.05 μm to 10 μm is formed on a principal surface thereof (a face to have the transferred metal plating film 8). The adhesive layer 21 may be obtained by applying, for example, pressure sensitive adhesives, such as acrylic (solvent type), acrylic emulsion based (aqueous type), butyral based, phenol based, silicone based, and epoxy based pressure sensitive adhesives, to a principal surface of PET film etc., and by drying them. For example, may preferably be used a pressure sensitive adhesives having an adhesive power adjusted so as to give 0.1 N/cm after dried.

[0067] Moreover, the adhesive layer 21 is preferably formed by materials that may certainly be pyrolyzed at comparatively low temperatures. In particular, preferably used are acrylic (solvent type), acrylic emulsion based (aqueous type), and butyral based pressure sensitive adhesives that may be pyrolyzed by calcining even with a metal plating film 8 attached thereon, and acrylic based pressure sensitive adhesives having excellent detachability may especially preferably be used among them. An adhesive power of the adhesive layer 21 is, for example, set as 0.005 N/cm to 1.0 N/cm, and in order to give excellent transfer property, it is preferably set at 0.01 N/cm to 1.0 N/cm, and furthermore in order to give excellent detachability, it is preferably set at 0.01 N/cm to 0.2 N/cm.

[0068] The resin film 20 is continuously supplied to a side of the base element 9 by the delivery part 22, and a side having the adhesive layer 21 is pressurized onto a surface of the base

element 9 with the metal plating film 8, for example, at a pressure of 10 N using the pressurizing roller 23. This operation transfers the metal plating film 8 on the resin film 20. Subsequently, the resin film 20 is taken up by the taking up part 24 at a same velocity as a peripheral velocity of the surface of base element 9.

[0069] The ceramic green sheet transfer means is constituted of a feed zone 28, a pressurizing roller 27, and a storage part 29. The feed zone 28 connects, with the motor, a shaft of the roll having the resin film 25 having the ceramic green sheet 26 rolled thereon, and rotates this shaft at a predetermined amount to deliver the film. The pressurizing roller 27 makes the ceramic green sheet 26 contact to the metal plating film 8 on the resin film 20 at a predetermined pressure. This operation transfers the ceramic green sheet 26 onto the metal plating film 8 on the resin film 20. The storage part 29 takes up the resin film 25 that passed through the pressurizing roller 27 at a fixed tension. As the pressurizing roller 27, may be used a roller having a same material and a same configuration as the pressurizing roller 23 described previously.

= Cleaning means =

[0070] Cleaning means 12 washes a surface of the base element 9 that is elevated up from the plating bath 18. It aims at specifically flushing a plating solution 1 remaining on the surface of the metal plating film 8 formed on a surface of the base element 9 or the mask layer 7.

[0071] This cleaning means 12 is constituted of a supplying

means for supplying a washing liquid to the surface of the base element 9 having the metal plating film 8 and the mask layer 7 formed thereon, and a reclaiming means for collecting the washing liquid used for washing. The supplying means supplies the washing liquid to a box for washing disposed close to the surface of the base element 9, and washes off a residual plating solution from the surface of the base element 9 by spraying to the surface of the base element 9 the washing liquid within the box for washing.

[0072] As washing liquids, for example, water, alcohol, acetone, toluene, etc. may be used. Impurities in the washing liquid are preferably controlled to not more than 1000 ppm. In addition, in order to obtain still higher cleaning effect, an air supply means for spraying air on the surface of the base element 9 may separately be provided.

= Washing liquid suction means =

[0073] The washing liquid suction means 13 is disposed in a downstream direction in a rotative direction with respect to the cleaning means 12 of the base element 9, and is used in order to thoroughly remove the washing liquid remaining on the surface of the metal plating film 8 and the mask layer 7, after washing of the plating solution 19 with the cleaning means 12.

[0074] This washing liquid suction means 13 is formed with a stainless steels plate etc., a surface thereof has a plurality of perforations for suction, and the washing liquid remaining on the surface of the base element 9 is removed by suction through

these perforations using a suction apparatus. Materials having fine openings formed therein may be attached to a surface portion of the washing liquid suction means 13, such as a urethane sponge or artificial leather. A shape of the washing liquid suction means 13 may be any of cylindrical, cylindrical column, and plate shape.

= Plating solution suction means =

[0075] The plating solution suction means 14 is disposed in an upstream direction in a rotative direction of the base element 9 with respect to the cleaning means 12, and is used in order to remove the plating solution 19 remaining on the surface of the metal plating film 8 or the mask layer 7.

[0076] This plating solution suction means 14 is formed with a stainless steels plate etc., and a surface thereof has a plurality of perforations like the previously described washing liquid suction means 13 to suck the plating solution 19 through these perforations. The surface portion of the plating solution suction means 14 adopts a same configuration as that of the washing liquid suction means 13. A shape of the plating solution suction means 14 may be any of cylindrical, cylindrical column, and plate shape.

= Circulation system =

[0077] The circulation system 15 is used in order to circulate the plating solution 19 introduced into the plating bath 18. A feed opening 16 of the plating solution 19 is provided in a part facing to a lowermost end part of the base element 9, in a center of a bottom of the plating bath 18. The plating solution 19 is

supplied into the plating bath 18 from this feed opening 16. In a rotative direction downstream of the base element 9, the plating solution 19 flows in a same direction as the rotative direction of the base element 9 along the surface of the base element 9, and in a rotative direction upstream of the base element 9, the plating solution 19 flows in a direction opposite to the rotative direction of the base element 9 along the surface of the base element 9, overflowing from ends of the plating bath 18. The overflowed plating solution 19 is discharged into a circulation tub disposed outside. Then the plating solution 19 collected in this circulation tub is sucked out from a sucking opening 17 provided in a bottom, and it is again supplied into the plating bath 18 from the feed opening 16 with the pump.

[0078] Furthermore, a filter may be provided in a path through which the plating solution 19 circulates in this way to remove foreign matters, and may be adjusted a pH value of the plating solution 19, a flow rate and a concentration of non-conductive micro-particles of the plating solution 19, etc., if necessary.

- Manufacturing process of electronic components -

[0079] Next, descriptions will be given for every step about a process for manufacturing a multilayer capacitor using the above-described apparatus for forming the plating film.

= Step 1=

[0080] First, a metal plating film 8 is formed on a surface of the above-described base element 9 by an electrolytic plating

method. Since a surface cross section of the base element 9 has a circular shape, a metal plating film 8 will also be formed so that a sectional configuration thereof may have a shape of convex curve with a same radius of curvature as that of the circle.

[0081] A lower area of the base element 9 is disposed so that it may be immersed in a sulfamic acid nickel plating liquid 19 etc. introduced into a plating bath 18, and a predetermined electric potential difference is applied between the base element 9 and a plating baths 18 so as to give a current density of, for example, 2 A/dm^2 to 15 A/dm^2, while rotating the base element 9 around a rotatable shaft 10 at a predetermined rotating speed. Thereby, a metal plating film 8 having a shape of a convex curve is formed onto areas excluding areas having the above-mentioned mask layer 7 on a circular surface of the base element 9.

[0082] A metal plating film 8 formed in this way comprises nickel, copper, silver, gold, platinum, palladium, chromium, etc., and alloy of these metals, and nickel exhibiting outstanding heat-resisting property is preferable as a material for forming an internal electrode 3 of a multilayer capacitor among these metal materials.

[0083] In this way, while immersing the base element 9, with rotation around a shaft, in a plating solution 19 in a plating bath 18, an electric field is applied between the base element 9 and the plating bath 18 to enable continuous formation of the metal plating film 8 on the surface of the base element 9, improving

productivity of the multilayer capacitor. Furthermore in this case, an almost uniform current density may be obtained between the base element 9 and the plating bath 18, enabling formation of the metal plating film 8 having an almost fixed thickness.

[0084] In this case also if a large number of non-conductive micro-particles 30 comprising ceramics and resins are added in the plating solution 19, a part of the non-conductive micro-particles 30 are embedded into the metal plating film 8 in a state of close contact with the base element 9. As a result, a metal plating film 8 including the non-conductive micro-particles 30 may be formed.

[0085] And after the metal plating film 8 formed on the surface of the base element 9 is elevated out of the plating solution 19 by rotation of the base element 9, the base element 9 is washed and dried by a plating solution suction means 14, by a cleaning means 12, and by a washing liquid suction means 13.

= Step 2=

[0086] In a following step, the metal plating film 8 obtained according to the step 1 is once transferred onto a resin film 20. This resin film 20 is sequentially delivered to a side of the base element 9 by a delivery part 22. A surface of the resin film 20 having an adhesive layer 21 formed thereon is pressurized by a pressurizing roller 23 to the surface of the base element 9 having the metal plating film 8 formed thereon at, for example, a pressure of 10 N. Thus the metal plating film 8 is transferred onto the resin film 20. Subsequently, the resin film 20 will be taken up

by a taking up part 24.

[0087] Here, in the step 1, the metal plating film 8 is formed so as to have a sectional configuration with a convex curve on the surface of the base element 9 with a circular shape. Therefore, in deposition of the metal plating film 8 to the resin film 20, when the obtained metal plating film 8 is detached from the base element 9 and deposited on the resin film 20, the metal plating film 8 having a shape of a convex curve transfigures toward planarization on the resin film 20, even if an internal stress (tensile stress) arises in the metal plating film 8. And thereby, the metal plating film 8 may be formed on the flat resin film 20 in a planar state without distortion.

[0088] In addition, when a large number of non-conductive micro-particles 30 comprising ceramics and resins are added into the metal plating film 8 on the base element 9, as mentioned above, low adhesive property of these non-conductive micro-particles 30 with the base elements 9 enables comparatively easier detach of the metal plating film 8 from the base element 9.

[0089] In order to improve detachability of the metal plating film 8, the non-conductive micro-particles 30 are preferably distributed in such a way that more non-conductive micro-particles 30 may be disposed in a surface of the deposited plating film (a part in contact to a conductive film 6). Especially, when an exposure area of the non-conductive micro-particles 30 exposed on a surface of the metal plating film 8 give a percentage of 0.01%

to 40% to a gross area of the metal plating film 8, the metal plating film may easily be detached from the base element, advantageously enabling beforehand suppression of deformation of the metal plating film. Less than 0.01% of this value increases a deposition percentage of the metal component in the metal plating film 8, and makes it difficult to fully reduce adhesion force with the base element 9, leading to possible deformation of the metal plating film in detaching the metal plating film from a surface of the base element. And since the value exceeding 40% will decrease an amount of a metal component in the metal plating film 8 and reduces mechanical strength of the metal plating film, cracks may arise in the metal plating film in detaching the metal plating film from the surface of the base element.

[0090] On one hand, when ceramic materials are used as such non-conductive micro-particles 30, preferably used are ceramic materials with same quality as that of the ceramic material for a ceramic green sheet 26 used as a dielectric sheet.

[0091] On the other hand, when micro-particles made of resins are used as the non-conductive micro-particles 30, preferably used are resins having same quality as that of organic binders included in the ceramic green sheet 26.

[0092] The non-conductive micro-particles 30 preferably have a mean particle diameter smaller than a thickness of the metal plating film 8. Such conditions can effectively prevent deformation of the metal plating film 8 in detaching of the metal

plating film 8 from the base element 9.

[0093] As such non-conductive micro-particles 30, non-conductive micro-particles 30 comprising ceramic materials and non-conductive micro-particles 30 comprising resin materials may be mixed for use.

= Step 3=

[0094] Next, a ceramic green sheet 26 as a dielectric sheet is further attached by pressure on a resin film 20 having a metal plating film 8 transferred thereon, and thereby the ceramic green sheet 26 is attached on the metal plating film 8.

[0095] The ceramic green sheet 26 is taken up by a roll of a feed zone 28 in a state being supported on a resin film 25 comprising, for example, 12 μm to 100 μm-thick PET film etc. When the ceramic green sheet 26 is delivered to a merging position with the resin film 20, both resin films 20 and 25 will be stacked, and the ceramic green sheet 26 contacts the metal plating film 8 on the resin film 20. While heating this portion at temperatures of approximately 70 °C with a heater installed in a pressurizing roller 27, the resin film 25 is pressed at an approximately 100-N pressure to the resin film 20 side by the pressurizing roller 27. This operation attaches the metal plating film 8 to the ceramic green sheet. Subsequently, the resin film 25 from which the ceramic green sheet 26 was removed is taken up by a storage part 29.

[0096] In this way, if after the metal plating film 8 is once transferred onto the resin film 20, the ceramic green sheet 26 is

attached in layers from upper side, the ceramic green sheet 26 will not have direct contact to a mask layer 7 on a surface of the base element formed with a harder material. And therefore excellent attach of the ceramic green sheet 26 on the metal plating film 8 may be attained without damage caused by contact with the mask layer 7 of the ceramic green sheet 26.

[0097] Moreover, since the metal plating film 8 is transfigured toward planarization as mentioned above when it is detached from the base element 9, even if a principal surface of the ceramic green sheet 26 is transferred to this metal plating film 8, occurrence of deformation or crack in the ceramic green sheet 26 or the metal plating film 8 may effectively be prevented. Therefore, the present invention can contribute to productivity drive of the multilayer capacitor 1.

[0098] A ceramic green sheet 26 supported on the resin film 25 may, for example, be formed to give a thickness of 1 μm to 20 μm. The sheet may be obtained in such a manner that a predetermined ceramic slurry obtained by adding and mixing organic solvents, organic binders, etc. to a ceramic material powder is applied onto the principal surface of the resin film 25 using a conventionally well-known coating method or printing method etc. so as to give a thickness after calcination of approximately 2 μm, and then the sheet obtained is dried.

[0099] A PET film with a thickness of 38 μm is used as the resin film 25. The ceramic slurry is applied onto a principal

surface of the resin film 25 so as to give a thickness after calcination of, for example, 2 μm, and then dried to prepare a resin film 25 with a ceramic green sheet 26. Next, the ceramic green sheet 26 on the resin film 25 is made to contact with a metal plating film 8 on the resin film 20, and the contact area is sandwiched by a pressurizing roller 27 with a radius of 100 mm and a length of 250 mm under a pressurization condition of 100 N and 70 °C to make the ceramic green sheet 26 attached by pressure to the resin film 20 with the metal plating film 8. Subsequently, the ceramic green sheet 26 is detached from the resin film 25.

= Step 4=

[0100] Next, two or more ceramic green sheets 26 with the metal plating film 8 obtained in the above-mentioned step 3 are prepared, they are temporarily pressurized at a pressure of 0.9 MPa while heated at a temperature of, for example, 60 °C, and subsequently they are attached by pressure under conditions of a temperature of 70 °C and a pressure of 50 MPa with a conventionally known hydrostatic pressure press etc. to form a stacked layer.

= Step 5=

[0101] And finally the stacked layer obtained in the step 4 is cut into a specified shape, and each obtained piece is calcined at an elevated temperature.

[0102] Calcination of the stacked layer is performed in such a manner that the stacked layer may reach to a temperature lower than a melting point of a metal forming the metal plating film 8,

and higher than a recrystallizing temperature of the metal at least at some point in time during calcination. This operation gives the ceramic green sheet 26 as a dielectric layer 4 of the multilayer capacitor, and the metal plating film 8 as an internal electrode 3.

[0103] Here, recrystallization of a metal represents a phenomenon that when a processed metallic material receives heating the metallic material rapidly softens bordering on a temperature to stabilize so as to reduce an internal strain. This temperature of starting recrystallization is called a recrystallizing temperature. For example, nickel has a recrystallizing temperature of 530 °C to 660 °C, and a melting point of 1458 °C; copper has a recrystallizing temperature of 200 °C to 250 °C, and a melting point of 1083 °C; and gold has a recrystallizing temperature of about 200 °C, and a melting point of 1060 °C. Therefore, when the metal plating film 8 comprises nickel, calcination of a stacked layer is performed, for example, at a temperature of 1300 °C.

[0104] Thus, the metal plating film 8 is calcined at temperatures lower than a melting point of a metal forming the metal plating film 8, and thereby a defect of breakage of the metal plating film 8 caused by melt of the metal plating film 8 in calcination may certainly be prevented, enabling formation of internal electrodes 3 having outstanding continuity.

[0105] Since a peak temperature in calcination of the stacked

layer is set in this case higher than a recrystallizing temperature of a metal forming the metal plating film 8, progress of recrystallization of the metal forming the metal plating film 8 in calcination moderately softens the metal, and thereby the ceramic particles in a ceramic green sheet 26 enter into a surface of the metal plating film 8. This phenomenon improves adhesion force between the metal plating film 8 and the ceramic green sheet 26, as a result enabling manufacture of a multilayer capacitor having smaller structure defects.

[0106] Furthermore, since a part of non-conductive micro-particles 30 are embedded in the metal plating film 8 in this case, in case of use of a ceramic material as non-conductive micro-particles 30, the non-conductive micro-particle 30 are concurrently calcined in calcination of the ceramic green sheet 26, and as a result, the non-conductive micro-particle 30 are sintered with a ceramic component included in the ceramic green sheet 26 to be unified. As a result, adhesive properties between the metal plating film 8 and the ceramic green sheet 26 may improve. And in use of a resin material as non-conductive micro-particles 30, the non-conductive micro-particle 30 are reduced to ashes in calcination of the ceramic green sheet 26 to form voids. Since the ceramic component in the ceramic green sheet 26 will be spread into the voids, also in this case, adhesive properties between the metal plating film 8 and the ceramic green sheet 26 may improve.

= Step 6=

[0107] Finally, a conductive paste for external electrodes is applied to both ends of a stacked layer by a conventionally well-known dipping method etc., and plating treatment is given to a surface thereof to form external electrodes 5 after calcination, and thereby a multilayer capacitor 1 as a product is completed.

- Modification 1 of a manufacturing process -

[0108] Next, descriptions will be given using Fig. 5 about another embodiment of the present invention. Overlapping descriptions about a same step as in manufacturing process of electronic components described previously will be omitted, and overlapping descriptions having identical referential numerals will also be omitted about configuration of the apparatus for forming the plating film.

[0109] This embodiment differs from manufacturing process described previously in a point that a metal plating film 8 once transferred on a resin film 20 is re-transferred onto a surface of a ceramic green sheet 26 currently maintained on a resin film 25.

[0110] In this case, the ceramic green sheet 26 having the transferred metal plating film 8 is taken up by a storage part 29 together with the resin film 26, and this will be used for subsequent steps.

[0111] Also in this second embodiment, completely same effect as in the first embodiment described previously may be obtained.

- Modification 2 of manufacturing process -

[0112] Next, descriptions will be given using Fig. 6 about another embodiment of the present invention. Overlapping descriptions about a same step as in manufacturing process of electronic components described previously will be omitted, and overlapping descriptions having identical referential numerals will also be omitted about configuration of the apparatus for forming the plating film.

[0113] This embodiment differs from manufacturing process described previously in a point that a metal plating film 8 directly deposited on a base element 9 is transferred onto a principal surface of a ceramic green sheet 26 currently supported on a resin film 25. That is, the resin film 25 comprising a PET film having the ceramic green sheet 26 currently supported thereon is delivered from a roll of a delivery part 22, and is attached by pressure to the base element 9 by a pressurizing roller 23. Thereby, the metal plating film 8 formed on the base element 9 is transferred onto the principal surface of the ceramic green sheet 26 currently supported on the resin film 25. A taking up part 24 takes up the resin film 25 having the metal plating film 8 transferred by passing through the pressurizing roller 23.

[0114] Also in the embodiment, completely same effect as in previous embodiments may be obtained. In this case, when a mask layer 7 of the base element 9 used for this apparatus for forming the plating film is formed of DLC, GLC, etc., the ceramic green sheet 26 hardly attaches to a surface of the mask layer 7, and thereby

stable transfer may be repeated.

- Modification 3 of manufacturing process -

[0115] Next, descriptions will be given using Fig. 7 about another manufacturing process of the present invention.

[0116] In previously described processes, no films were formed in a portion without a metal plating film 8 on a resin film having the metal plating film 8 transferred thereon. Therefore, a level difference arises between a portion on a resin film having a metal plating film 8 formed thereon, and portion with no films thereon.

[0117] Fig. 7 is a sectional view showing a process for forming a thin dielectric sheet 43 for filling a level difference into a portion without existence of the metal plating film 8 in a resin film 20 having a metal plating film 8 transferred from a base element 9, and having an adhesive layer 21.

[0118] During feeding of the resin film 20, pair of rollers 40 and 41 for pressurizing the resin film 20 from a front side and a back side is disposed. A resin film 42 having a supported dielectric sheet 43 with a thickness almost equal to a thickness of the metal plating film 8 is sent to the roller 40 contacting a principal surface of the resin film 20 having the metal plating film 8 formed thereon. A dielectric sheet 43 is preferably a ceramic green sheet.

[0119] The dielectric sheet 43 is pressed onto a principal surface of the resin film 20 with a pressure of the roller 40. At

this time, the dielectric sheet 43 is pressed to both of the part having existence of the metal plating film 8, and a part without existence, and thereby the dielectric sheet 43 may selectively be attached only to a part without existence of the metal plating film 8 among principal surfaces of the resin film 20, using cutting force of an edge of the metal plating film 8.

[0120] Thus, a planar metal plating film 8 having the dielectric sheet 43 embedded on the resin film 20 can be obtained. Onto this planar metal plating film 8 having this dielectric sheet 43 embedded therein, a ceramic green sheet 26 is to be transferred using ceramic green sheet transfer means described in Fig. 2 or Fig. 5.

[0121] Also in this process, in addition to completely same effect being obtained as in previously described embodiment, a large space will not be formed between the metal plating film 8 and the ceramic green sheet 26. Therefore, even if after detaching of the obtained sheet from the resin film 20, two or more sheets are laminated, and heat-treated to manufacture lamination type electronic parts, occurrence of electric defects caused by delamination or curvature of the electrodes may effectively be prevented, providing ceramic electronic components excellent in reliability and productivity.

- Modification 4 of manufacturing process -

[0122] Next, descriptions will be given using Fig. 8 about another manufacturing process of the present invention.

[0123] This embodiment differs from manufacturing process described previously in a point that a metal plating film 8 is formed in a state embedded in a ceramic green sheet 26.

[0124] This manufacturing process, as shown in an enlarged view of Fig. 8, a ceramic slurry 31 is applied from a nozzle 32 onto a principal surface of a resin film 20 having a transferred metal plating film 8 so as to cover the metal plating film 8, and is dried using a heater 33 to obtain a ceramic green sheet 26 having the metal plating film 8 embedded therein.

[0125] A stacked layer of the ceramic green sheet 26 may be formed by stacking two or more of the obtained ceramic green sheet 26 having the metal plating film 8, and the stacked layer is heat-treated in a heating furnace (not shown) to manufacture lamination type electronic parts.

[0126] Also in this process, in addition to completely same effect being obtained as in previously described embodiment, since the ceramic green sheet 26 obtained as described above does not have a large level difference formed between a part having existence of the metal plating film and a part without existence, deformation of the metal plating film currently embedded therein may effectively be suppressed, even in the case where a stacked layer is formed by stacking two or more of this ceramic green sheet 26, leading advantageously to effective prevention of occurrence of electric defects and delamination.

- Modification 1 of an apparatus for forming the plating film -

[0127] Next, descriptions will be given about another embodiment of the present invention using Fig. 9.

[0128] Characteristic of this embodiment is a point that a plating bath 18 is sectioned into a high electric potential area 18A serving as an anode, and a low electric potential area 18B serving as a cathode.

[0129] That is, a cathode of a power supply 6A is connected to a base element 9, and an anode of the power supply 6A is connected to the high potential area 18A of the plating bath 18. Furthermore, an anode of a power supply 6B is connected to the base element 9, and a cathode of the power supply 6B is connected to the low electric potential area 18B of the plating bath 18. A cathode of the power supply 6A and an anode of the power supply 6B are connected in common.

[0130] After a metal plating film 8 is deposited onto the surface of the base element 9 without existence of a mask layer 7, a surface portion of the once formed metal plating film 8, especially a contact portion between the metal plating film 8, and the base element 9 and the mask layer 7 is re-dissolved in the plating solution 19 with a reverse electric potential of the power supply 6B. This operation forms a minute space between the metal plating film 8, and the base element 9 and the mask layer 7, and improves detachability of the metal plating film 8, leading to improvement of precision of transfer to a transfer recipient material.

[0131] In the above-described plating bath 18, for example, the high potential area 18A and the low electric potential area

18B are electrically isolated by interposition, in a central part, of an insulating member 16A comprising vinyl chlorides etc. As the insulating member 16A, polytetrafluoroethylenes etc. may be used besides the above-described vinyl chlorides. In order to maintain sufficient insulation so that deposition and re-dissolving of the metal plating film 8 in both areas may appropriately be performed, preferably materials having a specific resistivity value of not less than 1000 Ω-m are used. The insulating member 16A preferably has chemical resistance, and has especially preferably acid-resistance.

[0132] In an upper part of the insulating member 16A and between the plating bath 18 and the base element 9, a partitioning member 16B for mutually separating plating solutions corresponding to each area may be formed with a predetermined distance toward a surface of the base element 9. By mutually separating the plating solutions corresponding to each area with this partitioning member 16B, mutual interference between electric fields corresponding to both areas may be avoided, and thereby deposition and re-dissolving of the plating solutions in each area may more appropriately be performed.

[0133] The insulating member 16A and the partitioning member 16B may be formed into one body as an insulated partition wall member 16 of an identical material. The insulated partition wall component 16 may also be used as a plating solution feed opening as a part of a circulation systems 15 mentioned later. In this

case, the insulated partition wall member 16 may be provided so that it may be hollow, and may have openings for delivering a plating solution in a plating solution 19 side in the plating bath 18.

[0134] An area of the plating bath 18 may be sectioned into still more parts by providing a plurality of insulated partitioning members 16. Such a configuration enables more suitable control of a plurality of electric fields corresponding to object, and formation of desired metal plating films.

- Modification 2 of apparatus for forming the plating film -

[0135] Next, descriptions will be given about an apparatus for forming the plating film concerning other embodiments of the present invention using Fig. 10 and Fig. 11.

[0136] This embodiment differs from manufacturing process described previously in a point that a surface, at least in a surface portion, of the base element 9 used for an apparatus for forming the plating film is sectioned into a plurality of blocks detachably supported with respect to a core part of the base element 9.

[0137] For example, as shown in Fig. 10, a base element 4 is constituted in such a manner that an insulating material 34 is formed so as to cover a whole surface side of a base element 4, and a plurality of insulated partition wall member 35 is disposed with a predetermined distance on the insulating material 34, and simultaneously a block member 36 having a mask layer 7 formed on a conductive film 6 may be inserted on the insulating material 34 and between the insulated partition wall members 35 using adhesives

etc.

[0138] Electric conductive rollers 37A and 37B are provided in different positions in the plating solution 19. The electric conductive rollers 37A and 37B are connected to a high potential area 18A and a low electric potential area 18B of the plating bath 18 via electric power units 6A and 6B, respectively. The block member 36 in contact with the electric conductive roller 37A has a positive high potential with respect to the plating bath 18, and the block member 36 in contact with the electric conductive roller 37B has a negative low electric potential with respect to the plating bath 18.

[0139] Furthermore, as shown in Fig. 11, block members 36 may be constituted so that the members may include not only a surface portion of a base element 4 but a core part thereof, and each block member 36 may have insulated partition wall member 35 radially extending toward a surface from a central part of the base element 4.

[0140] After deposition of a metal plating film 8 onto a surface of the base element 9 without existence of the mask layer 7 in the high potential area 18A, a surface portion of the once formed metal plating film 8, especially a contact portion between the metal plating film 8, and the base element 9 and the mask layer 7 is re-dissolved in the plating solution 19 with a reverse electric potential in the low electric potential area 18B. This operation forms a minute space between the metal plating film 8, and the base

element 9 and the mask layer 7 in the metal plating film 8 elevated from the plating solution 19, and improves detachability of the metal plating film 8, leading to improvement of precision of transfer to a transfer recipient material (resin film).

[0141] Since the mask layer 7 etc. may just be formed onto the block member 36 having a smaller surface area, production of the mask layer 7 to the block member 36 etc. using simple facilities may be attained. This embodiment enables replacement of only the block member concerned, when the mask layer 7 formed on a surface of the base element is selectively worn out, advantageously leading to excellent maintenance property.

[0142] The present invention is not limited to the above-described embodiments, and various changes and modifications may be made without departing from the spirit and scope of the invention. For example, although in the above-described embodiments, descriptions were given for cases of manufacturing of a multilayer capacitor as examples, the present invention is naturally applicable in manufacturing of electronic components other than multilayer capacitors, for example other electronic components, such as inductors, filters, and wiring boards.